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CURRENT NACA REPORTS

NACA TN 2467

THE AERODYNAMIC BEHAVIOR OF A HARMONICALLY OSCILLATING FINITE SWEPTBACK WING IN SUPERSONIC FLOW. Chieh-Chien Chang, Johns Hopkins University. October 1951. 76p. diagrs. (NACA TN 2467)

By an extension of Evvard's "diaphragm" concept outside the wing tip, two approximate methods are presented for calculating the aerodynamic behavior of harmonically oscillating, sweptback finite wings with both supersonic leading and trailing edges - one expressing the integration in terms of Fresnal integrals and the second one similar to the first except that a series expansion of the source-strength function is used. If the wing frequency parameter is small both methods give accurate results in the engineering sense without requiring undue computing skill. A number of graphs are presented to show pressure distribution of the wings at different Mach numbers, sweepback angles, and frequency parameters. Comparisons of pressure coefficients calculated from present methods and exact two dimensional solutions based on linearized theory are made.

NACA TN 2468

INVESTIGATION AT LOW SPEED OF 45° AND 60° SWEPTBACK, TAPERED, LOW-DRAG WINGS EQUIPPED WITH VARIOUS TYPES OF FULL-SPAN, TRAILING-EDGE FLAPS. John J. Harper, Georgia Institute of Technology. October 1951. 53p. diagrs., photos., 3 tabs. (NACA TN 2468)

An investigation was made to determine the low-speed aerodynamic characteristics of two sweptback, low-drag, tapered wings equipped with full-span split and slotted flaps and three special types of trailing-edge flaps. Sweep angles of 45° and 60° measured at the quarter chord were used. The results showed no appreciable gain in maximum lift coefficients for either the split flap or the special flaps on the 60° model but these same flaps did produce an increment in lift on the 45° model. The slotted flap produced the largest increase in lift on both models. The effect of the flaps on drag and pitching moment is the same as that indicated by other test data available. The slotted flap caused the largest increase in pitching moment for a given deflection angle. All flap configurations increased the stability of both wings.

NACA TN 2469

RUPTURE PROPERTIES OF LOW-CARBON N-155 TYPE ALLOYS MADE WITH A COLUMBIUM-TANTALUM FERRO-ALLOY. J. W. Freeman, E. E. Reynolds and A. E. White, University of Michigan. October 1951. 11p. diagrs., 2 tabs. (NACA TN 2469)

An experimental columbium-tantalum ferro-alloy was substituted for ferro-columbium in making laboratory heats of low-carbon N-155 alloy and an N-155 type alloy (20Cr-20Ni-20Co+2Cb). This substitution had no significant effect upon stress-rupture and creep properties of either alloy at 1200° and 1500° F. The results indicate the probable practicality of using high-tantalum ferro-columbium for making columbium-bearing heat-resistant alloys. In addition to using columbium not otherwise available, an actual reduction of the amount of columbium used is indicated.

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NACA TN 2472

FUNDAMENTAL EFFECTS OF COLD-WORKING ON CREEP PROPERTIES OF LOW-CARBON N-155 ALLOY. D. N. Frey, J. W. Freeman and A. E. White, University of Michigan. October 1951. 45p. diagrs., photos. (NACA TN 2472)

Effects of cold-working under various conditions on the creep resistance at 1200° F and on the internal structure of low-carbon N-155 were determined in part by microscopic examination and X-ray diffraction. Effects of annealing at various times and temperatures on creep resistance and internal structure of the cold-worked samples were also partially evaluated. Cold-working was found to improve the creep resistance of this alloy by the introduction of residual elastic stresses into the lattice. These stresses acted to prevent the movement of the fundamental creep flow units.

NACA TN 2474

EMPIRICAL RELATION BETWEEN INDUCED VELOCITY, THRUST, AND RATE OF DESCENT OF A HELICOPTER ROTOR AS DETERMINED BY WIND-TUNNEL TESTS ON FOUR MODEL ROTORS. Walter Castles, Jr. and Robin B. Gray, Georgia Institute of Technology. October 1951. 72p. diagrs., photos., 8 tabs. (NACA TN 2474)

The empirical relation between the induced velocity, thrust, and rate of vertical descent of a helicopter rotor was calculated from wind-tunnel force tests of four model rotors by the application of blade element theory to the measured values of the thrust, torque, blade angle, and equivalent free-stream rate of descent. The tests covered the useful range of the ratio of thrust coefficient to effective solidity and the range of vertical descent from hovering to descent velocities slightly greater than those for autorotation. Possible sources of discrepancy between

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previous flight and wind-tunnel test data are discussed and the principal effects of blade taper and twist on the vertical-descent characteristics are evaluated.

NACA TN 2475

SOME FEATURES OF ARTIFICALLY THICKENED FULLY DEVELOPED TURBULENT BOUNDARY LAYERS WITH ZERO PRESSURE GRADIENT. P. S. Klebanoff and Z. W. Diehl, National Bureau of Standards. October 1951. 55p. diagrs., photos. (NACA TN 2475)

Results are presented of tests to determine the feasibility of artifically thickening a turbulent boundary layer on a flat plate. It is shown that it is possible to do substantial thickening and obtain a fully developed turbulent boundary layer which is free from any distortions introduced by the thickening process. Measurements of mean velocity, spectrum of u-fluctuation, and intensity of u-fluctuation are presented. Some features of the fully developed turbulent boundary layer with zero pressure gradient are discussed. The mean flow in the boundary layer is compared with the logarithmic laws of mean-velocity distribution derived for pipes and channels, and the existing theories dealing with the shape of the spectrum in isotropic turbulence are applied to the spectrum measured in the outer portion of the boundary layer.

NACA TN 2496

FLIGHT INVESTIGATION OF A MECHANICAL FEEL DEVICE IN AN IRREVERSIBLE ELEVATOR CONTROL SYSTEM OF A LARGE AIRPLANE. B. Porter Brown, Robert G. Chilton and James B. Whitten. October 1951. 47p. diagrs., photos. (NACA TN 2496)

Data are presented showing the flight characteristics of a large airplane having a control-surface booster and mechanical feel device in the elevator-control system. The tests were made with various force gradients provided by the adjustable feel device. The booster was set to operate at a very high boost ratio throughout the tests so that the measured or apparent stick-free stability would be influenced only slightly by the aerodynamic hinge moments. The results show the effect of the feel device on the handling qualities of the test airplane and also the design features which should be incorporated in such feel devices.

NACA TN 2499

LAMINAR FRICTION AND HEAT TRANSFER AT MACH NUMBERS FROM 1 TO 10. E. B. Klunker and F. Edward McLean. October 1951. 22p. diagrs. (NACA TN 2499)

Velocity and temperature profiles and laminar boundary-layer characteristics have been computed for Mach numbers from 1 to 10, utilizing experimental values of the heat capacity, viscosity, and conductivity. The analysis shows that an effective temperature, which is a function of the surface temperature and stream conditions, arises naturally and is the proper reference temperature to be used in heat-transfer calculations. The effective temperature and the recovery temperature become identical for the condition of zero heat transfer.

NACA TN 2506

AN ANALYTIC DETERMINATION OF THE FLOW BEHIND A SYMMETRICAL CURVED SHOCK IN A UNIFORM STREAM. C. C. Lin and S. F. Shen, Massachusetts Institute of Technology. October 1951. 45p. diagrs. (NACA TN 2506)

A power-series-expansion method is used to determine the flow pattern behind a detached curved shock in a uniform stream. The limitations of the method are discussed and earlier applications are extended to include more terms and to give improved accuracy. The analysis is carried out in a manner applicable to both the two-dimensional and the axially symmetrical cases. The particular example with free-stream Mach number 1.7 is computed in the axially symmetrical case by using a fourth-degree polynomial to represent the flow and comparison is made with experimental results.

NACA TN 2509

A SELF-SYNCHRONIZING STROBOSCOPIC SCHLIEREN SYSTEM FOR THE STUDY OF UNSTEADY AIR FLOWS. Leslie F. Lawrence, Stanley F. Schmidt and Floyd W. Looschen. October 1951. 30p. diagrs., photos., tab. (NACA TN 2509)

A description and several examples of an application of a self-synchronized stroboscopic schlieren system are presented. The instrument provides for visual examination of unsteady flow phenomena occuring about aerodynamic bodies in wind tunnels. The frequency limitations of the instrument were arbitrarily selected for a particular test and may be varied by modifying electronic circuits of the system. Complete circuit diagrams are presented.

NACA TN 2510

EXPERIMENTAL VALUES OF THE SURFACE TENSION OF SUPERCOOLED WATER. Paul T. Hacker. October 1951. 20p. diagrs., photos., tab. (NACA TN 2510)

The surface tension of water has been determined experimentally for the temperature range, 0° to -22.2° C. The weak inflection point in the surface-tension - temperature relation, as indicated by the International Critical Table values for temperatures down to -8° C, was substantiated by the measurements in the temperature range, 0° to -22.2° C. The surface tension increases at approximately a linear rate from a value of 76.96 ± 0.06 dynes per centimeter at -8° C to 79.67 ± 0.06 dynes per centimeter at -22.2° C.

NACA TN 2511

CALCULATION OF HIGHER APPROXIMATIONS FOR TWO-DIMENSIONAL COMPRESSIBLE FLOW

BY A SIMPLIFIED ITERATION PROCESS. W. H. Braun and M. M. Klein. October 1951. 54p. diagrs., 10 tabs. (NACA TN 2511)

The iteration equations for a simplified solution of the nonlinear compressible-flow equation are developed and applied to two profiles, the ellipse and the Kaplan section. Limitations imposed on the solutions by simplifications in the differential equation and the boundary conditions are discussed. The velocities near the midchord, the critical and potential limit free-stream Mach numbers, and the extent of isentropic supersonic regions are calculated to four approximations for the Kaplan section and to six approximations for the ellipse. The development of the iteration equations and the presentation of the results are made in conformity with the Kármán transonic similarity law and comparisons are made with other solutions.

NACA TN 2513

EFFECTS OF SOME SOLUTION TREATMENTS FOLLOWED BY AN AGING TREATMENT ON THE LIFE OF SMALL CAST GAS-TURBINE BLADES OF A COBALT-CHROMIUM-BASE ALLOY. II - EFFECT OF SELECTED COMBINATIONS OF SOAKING TIME, TEMPERATURE, AND COOLING RATE. C. A. Hoffman and C. F. Robards. October 1951. 19p. diagrs., photos., 4 tabs. (NACA TN 2513)

An investigation was conducted to determine the effects of a number of solution and aging treatments on the life of small cast gas-turbine blades of Haynes Stellite alloy 21 (a cobalt-chromium-base alloy). Solution Treating at 2250° F followed by slow furnace cooling and subsequent aging was found to improve the mean life and the initial failure time of the blades. This improvement was confirmed by statistical analysis. Metallographic examination revealed the presence of a lamellar structure in the improved blades. Other treatments investigated did not improve blade life. The blades were operated at 1500° F and 20,000 pounds per square inch at the blade mid-span. Samples of 20 and 22 blades were used.

NACA TN 2517

AN INVESTIGATION OF AIRCRAFT HEATERS. XXXVII - EXPERIMENTAL DETERMINATION OF THERMAL AND HYDRODYNAMICAL BEHAVIOR OF AIR FLOWING ALONG A FLAT PLATE CONTAINING TURBULENCE PROMOTERS. L. M. K. Boelter, G. Young, M. L. Greenfield, V. D. Sanders and M. Morgan, University of California. October 1951. 26p. diagrs. (NACA TN 2517)

This report contains heat-transfer and pressure-drop data for air flowing over a heated flat plate containing strips of metal placed normal to the direction of air flow. The heat-transfer rates and static pressure drops are increased for this system over that for a flat plate alone because of the eddies, turbulence, and fin effect caused by the interrupters.

NACA TN 2520

EFFECTS OF PRESSURE-RAKE DESIGN PARAMETERS ON STATIC-PRESSURE MEASUREMENT FOR RAKES USED IN SUBSONIC FREE JETS. Lloyd N. Krause. October 1951. 20p. diagrs. (NACA TN 2520)

A subsonic-free-jet investigation was conducted to determine the effect of pressure-rake design parameters on static-pressure measurement. The design parameters investigated include: the location of the static orifices in relation to the tube nose and supporting strut; the proximity effects of adjacent tubes near the static orifices; and the effect of ratio of support diameter to jet diameter. The investigation covered a Mach number range of 0.3 to 0.95. Information and recommendations are provided for the design of pressure rakes to be used in subsonic free jets.

NACA TN 2521

LAMINAR BOUNDARY LAYER ON A CIRCULAR CONE IN SUPERSONIC FLOW AT A SMALL ANGLE OF ATTACK. Franklin K. Moore. October 1951. 44p. diagrs., tab. (NACA TN 2521)

The laminar boundary layer on a circular cone at angle of attack to a supersonic stream is discussed. A perturbation analysis was made to show the influence of a small angle of attack on such boundary-layer quantities as skin friction, boundary-layer thickness, viscous lift, drag, and pitching moment.

NACA RM E51H09

FLAME VELOCITIES OVER A WIDE COMPOSITION RANGE FOR PENTANE-AIR, ETHYLENE-AIR, AND PROPYNE-AIR FLAMES. Dorothy M. Simon and Edgar L. Wong. October 1951. 40p. diagrs., photos., 4 tabs. (NACA RM E51H09)

Fundamental flame velocities are reported for pentane air, ethylene-air, and propyne-air mixtures for the concentration range 60 to 130 percent of stoichiometric. A form of the Tanford and Pease equation, which includes a small constant velocity term independent of diffusion, will predict the observed changes in flame velocity.

NACA TM 1322

THEORY OF THIN-WALLED RODS. (O Teorii Tonkostennykh Sterzhnei). A. L. Goldenveizer. October 1951. 53p. (NACA TM 1322. Trans. from Prikladnaya Matematika i Mekhanika, v.13, Nov.-Dec.1949, p. 561-596).

Starting with the Love equations for bending of extensible shells, "principal stress states" are sought for a thin-walled rod of arbitrary but open cross section. Principal stress states exclude those local states arising from end conditions which damp out with distance from the ends. It is found that for rods of intermediate length, long enough to avoid local bending at a support, and short enough that elementary torsion and bending are not the most significant

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stress states, four principal states exist. Three of these states are associated with the planar distribution of axial stress and are equivalent to the engineering theory of extension and bending of solid sections. The fourth state resembles that which has been called in the literature "bending stress due to torsional", except that cross sections are permitted to bend and the shear along the center line of the cross section is permitted to differ from zero.

BRITISH REPORTS

N-10613*

Royal Aircraft Establishment (Gt. Brit.)
A UNIFIED THEORY OF SUPERSONIC WING FLOW, EMPLOYING CONICAL FIELDS. H. Multhropp. April 1951. 178p. diagrs. (RAE Aero 2415)

This paper attempts to unify the supersonic wing flow theory by employing conical fields with a single transformation. The theory is applied first to the case of wings wholly inside the Mach cone and then to problems of wings which are partly outside the Mach cone. Enough partial solutions are worked out to enable the full solution to be built up for a flat plate of any practicable plan form at incidence and sideslip. The problem of a wing with supersonic curved leading edges is treated. Gives results for wings of small finite thickness at zero incidence. For calculations for wings in which the effective incidence varies as the chordwise or spanwise coordinates, the conception of conical fields of different order than that used for constant incidence is introduced.

N-10634*

Department of Supply (Australia)
AN INVESTIGATION INTO ENGINE WEAR CAUSED BY DUST. R. V. Pavia. July 1950. 19p. diagrs., photos., 5 tabs. (Department of Supply. ACA-50)

A number of wear tests have been made on an R.1830 Twin Wasp single-cylinder engine with dust introduced into the intake air, to study the effects on engine wear of dust quantity, dust concentration, and dust size. The results show that generally the wear is proportional to the weight of dust fed, but the amount of wear produced by a given weight of dust decreases as the dust concentration increases. Maximum wear was obtained with a dust size of about 15 microns, while the wear with 100-micron dust was only half as much. A simple method, which agrees well with the experimental results, has been suggested for estimating the wear caused by a mixture of dusts with known individual wear characteristics.

UNPUBLISHED PAPERS

N-3136*

INFLUENCE OF THE FLUID BOUNDARIES ON THE LONGITUDINAL STABILITY OF BODIES. (Der einfluss von flussigkeitsgrenzen auf die langsstabilität von körpern). W. Albring. August 1951. 12p. diagrs. (Trans. from Zentrale für wissenschaftliches Berichtswesen der Luftfahrtforschung, Berlin. UM 6407, July 14, 1944).

Reports ideas on the problem of "nose-down tendency" of submarines near the surface. A marked increase in displacement at the nose has an adverse effect. If a hydrodynamically unfavorable shape is dictated by the purpose of application, the possibility of balance by a properly designed tail surface may still remain. This is confirmed by the derivation of stability equations. From these, a few rules have been derived for design. Researchers must determine the magnitude of interference by experiment.

N-9888*

ON THE USE OF LIGHT GASES FOR CLOSED-CYCLE HEAT ENGINES. (Uber die Verwendung von leichten Gasen für Wärmekraftmaschinen mit geschlossenem Kreislauf). J. Ackeret. 8p. diagr. (Trans. from Schweizerische Bauzeitung, v.127, 1946, p.51-52).

Although the conventional operating medium for closed-cycle heat engines is air, it should be of interest to see whether further progress could be achieved by the use of other gases. This report discusses the most essential points, but leaves out a number of problems, especially those of the operation. It is noted that for the cycle efficiency, without consideration of the temperature and pressure losses, the nature of the gas plays no part. It is assumed that only gases and gas mixtures of the same atomic structure are employed.

N-10759*

THE INTERFERENCE EFFECT OF A WIND TUNNEL WITH MIXED CONTOUR. (Sull'interferenza di una Galleria Aerodinamica a Contorno Misto). Enrico Pistolesi. August 1951. 33p. diagrs. (Trans. from Pontificia Accademia delle Scienze, Commentationes, v.7, no.5, p.75-100).

This report deals with the case in which the free vortex system of the wing is formed by a couple of concentric vortices or by a continuous distribution of vortices. The development is limited so that the formulas retain their generalities. The results are applied to two specific cases: (1) circulation constant along the span, and (2) elliptic circulation distribution.